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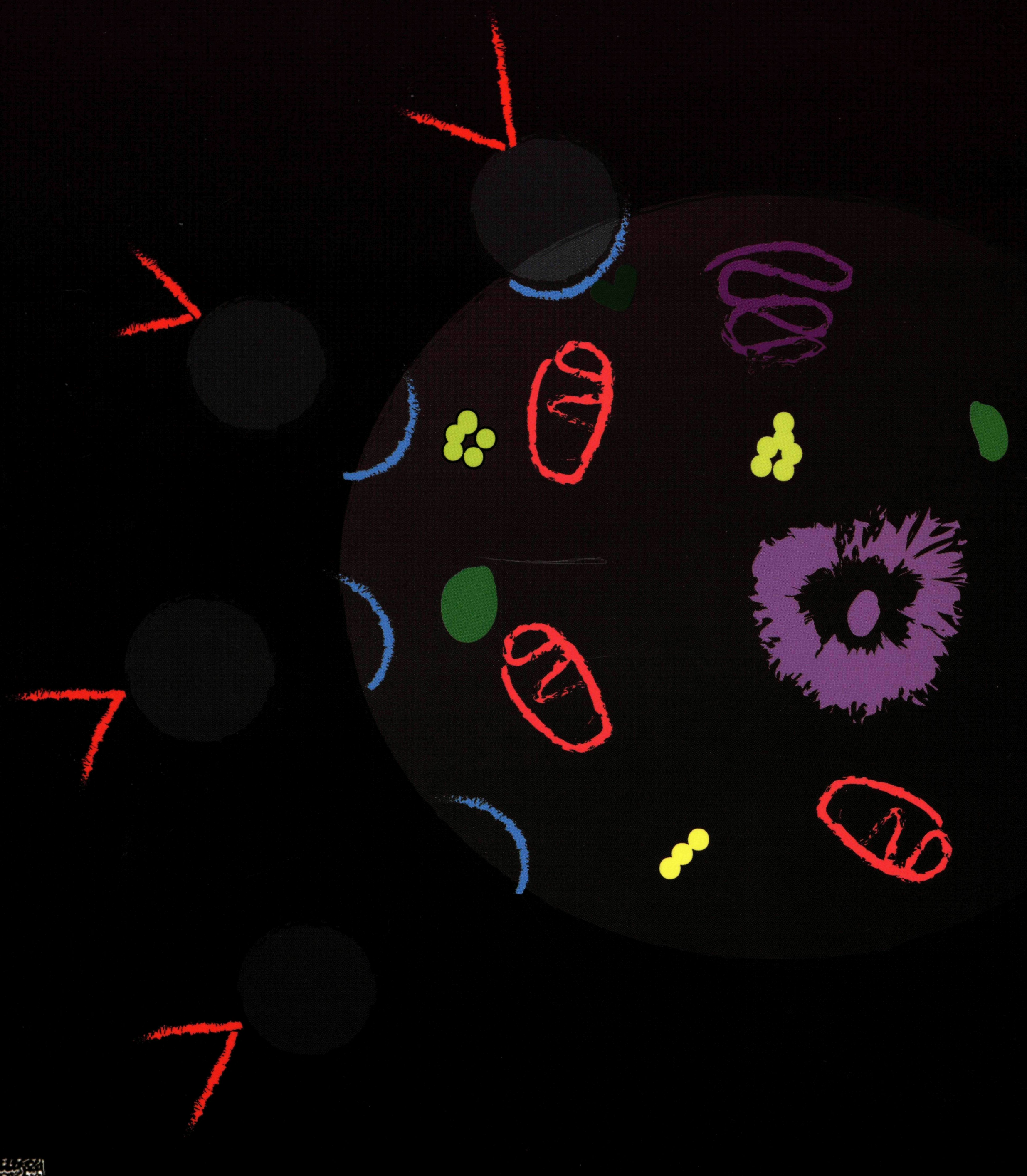

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Original Article

Feasibility of Using Latex Examination Gloves as Dental Dam: A Tensile Strength Study

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Abstract

Objective: To evaluate feasibility of hand gloves as a rubber dam isolation alternative, in respect of physical properties. ***Materials and Methods:*** A randomized controlled trial study design was used. Three types of gloves were tested with two types of a rubber dam used as the control group. Cut-out pattern of dumb-bell shapes were made from 35 samples for each type of groups and tensile strength were tested using Universal Testing Machine and the Trapezium X software. All tests for physical requirements were performed in accordance with American Society for Testing and Materials D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension. Findings were analyzed by analysis of variance (ANOVA) and differences were compared using a Tukey-Kramer interval calculated at the 0.05 significance level. ***Results:*** Heavy gauge rubber dam has the highest Mean (calculated at the 0.05 significance level) except for maximum stress calculated at entire area. Medium-gauge rubber dam has significantly higher tensile strength (44.5075 N/mm^2) when compared to heavy-gauge rubber dam (35.7787 N/mm^2) although it was 0.09mm thinner. Discovery 2020 Powder Free Latex Examination Gloves with tensile strength value of 28.5922 N/mm^2 (±3.27366) is more than the minimum requirement specified by American Federal Specification ZZ-R90B Rubber Dam (Dental, 1985) (4000 pounds per square inch or 27.6 N/mm^2). For all variable tested, all groups are significantly different from each other. The mean square between the groups was quite large. ***Conclusion:*** This study shows that there are significant differences between the physical strength of latex gloves when compared to rubber dam. However, the comparison between thickness and tensile strength among various rubber dam, did not correspond proportionately. Only one type of rubber gloves met the minimum requirement but that is just one aspect. In view of these mixed results, more research is needed before we can conclude that it is feasable that we use hand gloves to replace rubber dam.

Key words: *Dental dam, latex examination gloves, physical properties, tensile strength.*

Introduction

As the mirror and probe are two instruments representing the global federation of the dental profession, so does the hand gloves and rubber (dental) dam which insulates the staff and pa-

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tients from many infectious diseases and hazardous situations.

Sanford Christie Barnum first advocated the use of rubber dam almost 150 years ago [1]. Even in that era of dentistry, the benefit of isolating a tooth to obtain a dry working field, free of salivary contamination, was appreciated [1]. This material is produced as a thin sheet of natural latex that is usually available in at least three different weights (thin, medium, and heavy) [2]. The use of the rubber dam during root canal treatment confers three main advantages: control of cross-infection, physical protection and improving treatment efficiency [3]. The benefits of rubber dam placement are now well known and accepted as a standard of care by professional organizations such as European Society of Endodontology 1992, 2006 [5], American Association of Endodontists 2004, and American Academy of Pediatric Dentistry 2008-2009 [3]. In spite of this, a review study done by I. A. Ahmad, 2009 stated that studies have cited a variety of reasons for lack of regular use of rubber dam amongst the dental profession. The most commonly reported reasons include lack of patient acceptance, time required for application, insufficient training, difficulty in use, the cost of equipment and materials and low treatment fees [3]. Several respondents also suggested that patients did not like rubber dam being used [10].

While more than one factor is associated with lack of regular use of rubber dam, a technique that has a clear infection control benefit and medico-legal and safety implications should not be excluded from use for reasons of cost [3]. Thus, one of the aims of this study is to explore the potential use of latex examination gloves as a replacement material in effort to overcome the cost issue associated with rubber dam use.

Why hand gloves?

This study is focused on the usage of latex examination gloves because it is cheap and readily available in dental clinics. Examination gloves are also made from the same resource as a dental rubber dam, which is rubber, and share similar properties like elasticity, stretch ability and impermeability [2] which makes it a suitable alternative for the more expensive rubber dam (dental). Despite these similarities, the quality, quantity and type of ingredients used in the manufacturing of rubber dams and latex gloves may differ and the way each of these materials are handled before and after compounding also will result in different tensile and tear properties [2]. Hence a study needs to be done to evaluate whether the latex examination gloves has the physical properties needed for a rubber dam [2]. The purpose of this study was to compare the tensile and tear properties of two different weights of rubber dam and three different types and manufacturer brand of gloves. The manner in which the tensile and tear properties can be determined is described in the American Society for Testing and Materials (ASTM) D412- Standard Test Properties for Rubber Properties in Tension. [2].

Material and Methods

This is a randomized controlled trial study testing for tensile strength of three (3) types of gloves and two (2) types of rubber dam as a control group. The rubber dams and gloves used for this study were obtained from the

Sample	Type/brand
1	Cross Protection Powder Free Latex Examination Gloves
2	Rainbow Dental Dam Powder Free (Medium Gauge)
3	Rainbow Dental Dam Powder Free (Heavy Gauge)
4	Cross Protection Powdered Latex Examination Gloves
5	Discovery 2020 Powder Free Latex Examination Gloves

Faculty Dentistry of University Technology MARA clinic. The types and brands of the gloves and rubber dam used in this study include:

Thirty five test pieces were prepared for each sample type. Each test piece is prepared as a dumb-bell shape (Figure. 1) using a slicing machine with a continuous band blade. Each test piece is made out of a size M gloves obtained from the palm area.

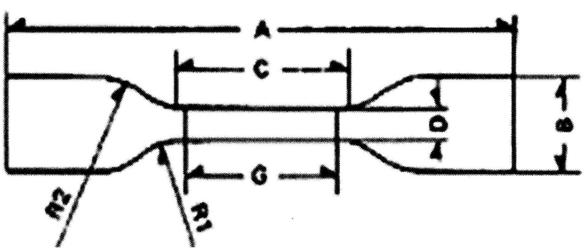

Figure 1: Dumb-bell test piece.

Width (D) and gauge length(C) were measured using a metal ruler and recorded. For each type of sample, thickness was measured using electronic veneer caliper and recorded.

All tests for physical requirements were performed in accordance with ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension [11]. For this research, the Universal Testing Machine with Trapezium X software was used. Relevant sample data such as thickness (mm), width (mm) and gauge length (mm) was inserted into the software.

The sample was set in between two jigs with a gauge length 45mm and the calibration of the machine was done using Vernier caliper. A uniform pressure was exerted across the width and surface area of the test piece. Test speed was set at 500 mm/min for all samples.

When tensile loads are applied to rubber materials, they elongate and their thickness decreases to a breaking point. Values of force stroke, stress stroke, stroke strain, maximum displacement stress and stroke, maximum displacement, maximum stress calculate at entire area, maximum force calculate at entire area, maximum displacement strain, maximum displacement time, maximum stroke calculate at entire area, maximum stroke strain calculate at entire area, maximum displacement calculated at entire area, maximum strain calculate at entire area, maximum time calculated at entire area and force 1 Newton were calculated using the Trapezium X software. In this research, the stress over strain relationship was used as a measure of tensile strength. Means and standard deviation were calculated, and data for maximum displacement (%), maximum forces (N), maximum stress (N/mm^2 or MPa) and maximum strain (%), maximum stroke (mm) were recorded.

All the data were inserted in SPSS version 21. Analyses to compare between gloves and rubber dam for variables tested were done using 1-way ANOVA. Differences between groups were analyzed using a *Tukey-Kramer Post-Hoc* test, calculated at the 0.05 significance level. Differences between the two means that were larger than the calculated Tukey HSD interval were considered statistically significant ($p < 0.05$).

Result

Results from a total of 175 samples consisting of 3 different types of latex gloves and 2 different weights (medium and heavy) of rubber dam

Brand	N	Maximum displacement strain (%)	Maximum forces calculated at entire area (N)	Maximum stress calculated at entire area (N/mm^2 or MPa)	Maximum strain calculated at entire area (%)	Maximum stroke calculated at entire area (mm)
	Mean (SD)					
Cross Protection Powder Free Latex Examination Gloves	35	701.62 (9 .62P)	9.43 (8 362)	21.43 (.432P)	678.81 (8.81Pr)	305.46 (5.46Pr)
Rainbow Dental Dam Powder Free (Medium Gauge)	35	959.07 (2 .07w)	30.26 (1 267)	44.50 (.507w)	919.73 (9.73w)	413.88 (3.88w)
Rainbow Dental Dam Powder Free (Heavy Gauge)	35	1023.53 (523.53)	37.20 (9 205)	35.77 (7 775)	990.03 (0.033)	445.51 (5.513)
Cross Protection Powdered Latex Examination Gloves	35	789.80 (9.80Pr)	10.11 (.110P)	25.29 (.290P)	769.43 (9.43Pr)	346.24 (6.24Pr)
Discovery 2020 Powder Free Latex Examination Gloves	35	762.36 (3 .36e)	10.29 (.296e)	28.59 (.596e)	731.82 (1.82er)	329.32 (9.32er)
Total	175	31.12 (3.122er)	19.46 (2.4.02)	368.08 (48.08)	817.96 (87.96er)	847.27(97.27e)

Table 1: Descriptive Statistics of Variables of Interest

		df	Mean square	F	Sig.
Maximum displacement strain (%)	Between Groups	4	658801.526	198.953	.000
	Within Groups	170	3311.351		
Maximum forces calculated at entire area (N)	Between Groups	4	6156.673	1295.953	.000
	Within Groups	170	4.751		
Maximum stress calculated at entire area (N/mm^2 or MPa)	Between Groups	4	2930.646	271.917	.000
	Within Groups	170	10.778		
Maximum strain calculated at entire area (%)	Between Groups	4	604631.731	212.355	.000
	Within Groups	170	2847.272		
Maximum stroke calculated at entire area (mm)	Between Groups	4	122437.845	212.355	.000
	Within Groups	170	576.571		

Table 2: Analysis of Variance (ANOVA)

were recorded. The mean values and standard deviation of variables of interest for the different sample groups are presented in Table 1.

Table 1 displays the descriptive analysis of maximum displacement strain, maximum forces calculated at entire area, maximum stress calculated at entire area, maximum strain calculated at entire area and maximum stroke calculated at entire area for the 5 different groups of sample. Results shows that heavy gauge rubber dam has the highest mean value for almost all variable tested except for maximum stress calculated at entire area.

A one way between subject ANOVA was conducted to compare the maximum displacement strain, maximum forces calculated at entire area, maximum stress calculated at entire area, maximum strain calculated at entire area and maximum stroke calculated at entire area in three different types and manufacturer of gloves and two different types of rubber dam which are Cross Protection Powder Free Latex Examination Gloves, Rainbow Dental Dams Powder Free (Heavy Gauge), Rainbow Dental Dams Powder Free (Medium Gauge), Cross Protection Powdered Latex Examination Gloves, Discovery 2020 Powder Free Latex Examination Gloves (Table 2).

There was a statistically significant difference at the $p<0.05$ level in maximum displacement strain, maximum forces calculated at entire area, maximum stress calculated at entire area, maximum strain calculated at entire area and maximum stroke for the five groups

The effect size using ETA squared was 0.82, 0.97, 0.86, 0.83, 0.83 respectively. The mean square between the group was quite large indicating that the difference in mean scores between the groups was also quite large.

Post Hoc comparison using the Tukey HSD test indicated that the mean maximum displacement strain percentage, maximum forces calculated at entire area, maximum stress calculated at entire area, maximum strain calculated at entire area and maximum stroke calculated at entire area for Group 1 (M=701.6269, SD=75.61201) was significantly different from Group 2, Group 3, Group 4, and Group 5. All groups are significantly different from each other.

Discussion

The manufacturer of a rubber dam (Sanctuary Health ISO 9001 and ISO 13485) stated that the minimum tensile strength of a rubber dam is 24.0 MPa meanwhile in Standard Malaysian Gloves (SMG) did state the minimum tensile strength of gloves is 18.0 MPa to meet the ASTM D3578, Standard Specification for Rubber Examination Gloves [13]. These differences were statistically significant; however, these differences are not considered to have any clinical relevance because rubber dam will not be stretched to its limits during clinical usage. There may be a question as to the usefulness of this tensile strength test with modern-day dental dam [2].

In descriptive analysis, all variable tested shows that heavy gauge rubber dam has the highest mean (± SD) value for almost all variable tested except for maximum stress calculate at entire area. In maximum stress calculate at the entire area (N/mm^2), medium-gauge rubber dam has highest mean (±SD) which was 44.5075 (±3.63074) compared to heavy-gauge rubber dam which was 35.7787 (±3.49714). When comparing heavy-gauge rubber dam and medium-gauge rubber dam, there was a significantly higher tensile strength for medium-gauge rubber dam, yet the material was 0.09 mm thinner than heavy-gauge rubber dam. The maximum stress calculate at entire area (tensile strength, MPa) test did show significant differences in comparisons of weight (thickness) for rubber dam, however, these results were inconsistent and incongruous. The heavy-gauge rubber dam had a thickness that was 0.09 mm thicker than the medium-gauge rubber dam material, yet it had approximately higher tensile strength.

The value (>27.6 MPa) called for in the federal specification ZZ-R-690B Rubber Dam [14] shows that Rainbow Dental Dam powder-free of two different weights (medium-gauge and heavy-gauge), complied with the specification for rubber dam as the maximum stress calculate at entire area (tensile strength, MPa) for medium-gauge rubber dam and heavy-gauge rubber dam are 44.5075 (±3.63074) and 35.7787 (±3.49714). The value stated by federal specification ZZ-R-690B Rubber Dam may give rise to the possibility for Discovery 2020 Powder Free Latex Examination to be rubber dam as tensile strength value for this Discovery hand gloves is within value stated (>27.6 MPa) which is 28.5922 (±3.27366). This shows that further test on different types of brand for gloves in comparison to rubber dam can be done.

Moreover, the universal testing machine used in this study was equipped with grippers that were not suitable in rubber tensile tests. The thin rubber dam and glove material may prematurely tear away or at least break free from the grippers making favorable measurements impossible. The gripper grip-surfaces were the grooved metal type, so to prevent the samples from tearing, a layer of adhesive cellophane tape were stuck to them. There were no observable occurrences of tearing of samples at the gripper interface.

Limitations of this study include the short period of time allocated, which was less than one year. Furthermore only rubber dam and gloves tested were of latex. Other materials from Nitrile and Vinyl may be included in future tests.

Conclusion

This study shows that there are significant differences between the physical strength of latex gloves when compared to rubber dam. Even though the findings show that the feasibility of using latex hand gloves as rubber dam is not promising based on their tensile strength alone, the findings are limited to the brands tested. Hence, it may be worthwhile to repeat this study using a more specific rubber tensile test machine or using different material of gloves before a definitive report on the feasibility of using hand gloves as rubber dam can be made.

Acknowledgement

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Provide a title page, containing the following items.

i) The type of paper
ii) Title. The title should be informative and as short as is consistent with clarity. The title should not include chemical formulae or arbitrary abbreviations, but chemical symbols may be used to indicate the structures of isotopically labeled compounds. The numbering of parts in a series of papers is not permitted, but titles and subtitles may be used if necessary.
iii) Next-line. List full names of all authors. A footnote reference(s) to an author(s), indicating a change of address, should be given on the title-page.
iv) Next-line. List the institution(s) in which the work was carried out, and the Zip Code / post code, if available.
v) Running title. Provide a short running title of less than 50 strokes. It should be as informative as possible.
vi) The name, complete mailing address, telephone number, Fax number, and E mail address of the person to whom correspondence should be sent. To expedite the review, much of the journal's correspondence will be by E mail.
vii) Abbreviations. Non-standard abbreviations should be defined, even if they are known to those familiar with the field. List all non-standard abbreviations used in the paper in alphabetical order in a footnote on the title page.

Customary abbreviations in wide use need not be defined in text (e.g., RNA, ATP). Define other abbreviations the first time that they are used. Refer to the Journal of Biological Chemistry for recommended abbreviations for biological compounds, Chemical Abstracts for names of chemical compounds, Conn's Biological Stains (10th Edition, RW Horobin and JA Kiernan (eds.), BIOS Scientific Publishers) for nomenclature, and the CSE Style Manual (2006, 7th ed., Council of Science Editors) for scientific abbreviations. Use SI units only. The Journal does not print the degree symbol before temperature symbols. All temperatures are printed as follows: 80C, 37.4F, 276K.

2. Abstract

i) The Abstract should ***not exceeding 250 words***. Abstract text should be divided into the following sections: **Objectives** (a brief statement of the purpose of the investigation along with the the working hypothesis)- **Materials and Methods** (A brief description of the materials and experimental method used); **Results** (state the results simply and clearly so that significant facts can be readily identified, where appropriate, statistics should be clearly stated); **Conclusions** (a brief summary of the essential results you believe were demonstrated by the experimental data and the impact of the results). Abstract should be in a form comprehensible to any scientist and suitable for publication without the full article text.

Avoid statements such as "The significance of these results is discussed" that do not help the reader. The abstract should be intelligible to the non-specialist as well as the specialist in your field, and hence should avoid specialized terms and abbreviations.

ii) **Key words**. Provide 3-5 key words identifying the nature of the subject matter alphabetically in the last part of the summary.

3. Introduction

The main part of an article should start with a brief Introduction, which outlines the historical or logical origins of the study and clearly states the aim of the study and/or hypothesis to be tested, without repeating the abstract or summarizing the results. Avoid giving an extensive review of the literature.

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The materials and methods section should provide a sufficient detailed description of the methods to allow a researcher to reproduce your work. Companies from which materials were obtained should be listed with their location: city and state, province or country.

The **Experimental Procedures** or **Materials and Methods** should give sufficient details to enable the reader to repeat your work exactly, if necessary. **The necessity for conciseness should not lead to omission of important experimental details**. Refer to previously published procedures employed by citation of both the original description and pertinent published modifications, and do not include extensive description unless they present substantially new modifications.

This section should present clearly but succinctly the experimental findings. Only results essential to establish the main points of the work should be included. Numerical data should be analyzed using appropriate statistical tests.

For guidelines on how to report statistical results, see Bailar, JC, Mosteller, F (1988) Guidelines for statistical reporting in articles for medical journals. Ann Intern Med, 108:266-273; Curran-Everitt, D, Benos DJ, (2004) Guidelines for reporting statistics in journals published by the American Physiological Society. J Neurophysiol, 92:669-671; Lang, TA, Secic, M (2006) How to report statistics in medicine: annotated guidelines for authors, editors and reviewers, 2nd edition, Philadelphia, PA, ACP Press; Sarter M, Fritschy JM (2008) Eur J Neurosci 28:2363-2364. compact presentation.

Experimental animals: When experimental animals are used, specify ***species, strain, sex, age, supplier, and numbers of animals*** used in total and for individual experimental conditions. The species should be identified in the Title or Abstract.

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The observations should be presented with minimal reference to earlier literature or to possible interpretations. The main statistical results should be reported in the Results section. The description of the statistical results should include the proper statistical term (such as the F statistic) as well as the degrees of freedom and the

P value. The description of statistical results in the figure legends should be limited to important post hoc comparisons.

Statistical methods should be described with enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. When possible, findings should be quantified and appropriate measures of error or uncertainty (such as confidence intervals) given. Details about eligibility criteria for subjects, randomization and the number of observations should be included. The computer software and the statistical method(s) used should be specified with references to standard works when possible

6. Discussion

The discussion section presents the interpretation of the findings, this is the only proper section for subjective comments. The discussion section should be as concise as possible and should include a brief statement of the principal findings while avoiding repetition of statements provided in the Abstract or the Results section.

A discussion of the validity of the observations, a discussion of the findings in light of other published work dealing with the same or closely related subjects, and a statement of the possible significance of the work. Extensive discussion of the literature is discouraged.

7. References

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10. Acknowledgements

A short statement about grant and other financial support should be given, along with a list of contributions from collaborators who are not co-authors (it is implicit that they agree with this mention), and a declaration of competing interests. See above under Editorial Policies for additional items to be addressed in the Acknowledgements.

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